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(54) IMPROVEMENTS IN OR RELATING TO DECORATIVE LAMINATED STRUCTURES

(71) We, DAI NIPPON PRINTING CO., LTD., a Japanese Joint Stock Company, of No. 1—12, Ichigayakagacho, Shintu-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be grated to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to decorative laminated structures and methods of making the same. The term "concaves" as used herein refers to recesses, such as grooves, in a surface and the term "convexes" refers to the non-recessed "lands" therebetween.

Reference is made to our application no. 57086/72, serial no. 1,413,158, in which there are also described decorative laminated structures and methods of making the same.

There have heretofore been proposed various kinds of decorative laminated structures for use not only as a material of a ceiling, floor or wall of a building or a car or ship fitting but also in furniture, musical instruments and the like. Recently, however, many consumers have become dissatisfied with conventional decorative laminated strutures having only a flat and smooth, decorated surface. There has been an increasing demand for an aesthetic laminated structure which has on its surface a sophisticated and complicated pattern or design with a three dimensional effect. As laminated structures provided on their surfaces with patterns of a three dimensional effect, there have been known those having a surface with a pattern composed of various shapes of concaves and convexes.

As examples of the laminated structures having such a pattern composed of concaves and convexes, there have been provided structures comprising a suitable base on which is provided a pattern imitating the grain of wood, stone or cloth pattern or the like, and concaves formed thereon. Such concaves are usually formed on grain pattern portions when a pattern of grains of wood is employed, on crack portions when a stone pattern is employed, or as a part of the weave when a cloth pattern is employed. Thus, there have been provided decorative laminated structures with realistic patterns providing an illusion of depth. In forming the concaves and convexes on the surface of the above-mentioned decorative laminated structures, a method is generally employed such that a metallic mould roll or metallic mould plate having on its surface a pattern composed of a mirror image of the required concaves and convexes is pressed onto the surface of the base to effect an embossing operation. In practising such method, it is necessary to provide a metallic mould roll or metallic mould plate both of which are expensive to manufacture due to the necessity of highly skilled craftsmanship for their production, leading to a high cost of the resulting product. Moreover, it is very difficult to form fine and detailed shapes of the mirror image of the required concaves and convexes on the metallic mould roll or plate and hence, the pattern of such metallic mould roll or plate tends inevitably to be of comparatively simple concave and convex shape. Consequently, with such conventional method, it is extremely difficult to make, on the surface of the laminated structures, such a pattern of fine and detailed concaves and convexes for imparting to the product realism and three dimensional effect.

Furthermore, it is noted that in practising the method employing a metallic mould roll or plate, the following additional difficulties or disadvantages are encountered:

1) When a different pattern of concaves and convexes is desired, it is necessary to prepare an additional metallic mould roll or plate having a pattern corresponding to the different pattern, leading to high cost.

2) When employing a metallic mould roll or plate having a mirror image pattern of the required concaves and convexes, it is very difficult to effect an embossing process while coordinating the mirror image pattern of the required concaves and convexes of the metallic mould roll or plate with the pattern previously formed in the surface of the laminated structure. Even slight misalignment causes the commercial value of the product to be reduced.

3) Since the embossing process is conducted mechanically employing a mould roll or plate made of metal, the surface of the laminated structure to be decorated will frequently be damaged during the processing operation.

The present invention consists in a decorative laminated structure comprising a base, a sheet made from a heat-shrinkable resin, and a composite pattern consisting of one or more layers applied thereto, the composite pattern comprising a first pattern of a heat-sensitive ink composition contacting the resin sheet and containing a heat-absorbing colouring agent and a second pattern, comprising the parts of the composite pattern not covered by the heat-sensitive ink composition of the first pattern, of a heat insensitive ink composition, the portions of the heat-shrinkable resin sheet covered by the first pattern having been shrunk to form concaves, at least some of which form holes through the heat-shrinkable resin sheet.

The present invention also consists in a method of making a decorative laminated structure, in which a laminated structure, comprising a base and a sheet of heat-shrinkable resin on which is applied a first pattern consisting of heat absorbing areas, is irradiated with infra-red or near infra-red radiation, heat energy being absorbed by the areas of the first pattern to heat up and cause to shrink and form concave portions of heat-shrinkable resin sheet covered thereby, the amount of radiation and variations in heat absorbing properties of the first pattern resulting in at least some of the portions shrinking to such an extent that holes are formed in the heat-shrinkable resin sheet, a second pattern of heat unsensitive ink composition being applied either before or after irradiation on the heat-shrinkable resin sheet and consisting of at least one layer, the second pattern including at least those areas of the heat-shrinkable resin sheet not covered by the first pattern. It has been found that when the decorative laminated structure obtained by the above-mentioned procedures is further heat-treated at elevated temperatures while supporting the peripheral ends of the structure to effect heat fixation of the heat-shrinkable resin sheet, the thermal stability, especially resistance against heat distortion, of the decorative laminated sttructure is greatly improved.

The heat-shrinkable resin sheet used for forming the decorative laminated structure of this invention may be formed of any thermoplastic resin which is heat-shrinkable. Examples of such heat-shrinkable resins include polyvinyl chloride, polyvinylidene chloride, polyolefines such as polyethylene and polypropylene, polyesters, polyamides, polystyrene, polycarbonates, polyvinyl alcohol, and other synthetic thermoplastic homopolymers and copolymers. These sheets are usually employed after they have been uniaxially or biaxially stretched by a conventional stretching method. When the heat sensitive areas of the starting laminated structure are irradiated, they selectively absorb the heat energy and thus are heated and shrink the heat-shrinkable resin sheet locally at portions covered by the heat sensitive areas to form concaves. Accordingly, the resin sheet to be used in this invention should be one that has not been subjected to a heat fixation treatment or one that, if it has been subjected to a heat fixation treatment, still retains sufficient heat shrinkability to exhibit the above-mentioned local shrinkage under infrared irradiation. In other words, a thermoplastic resin sheet cannot be used in this invention, if it has already been subjected to a heat fixation treatment and has thereby lost completely its heat shrinkability.

The thermoplastic resin sheet may be uncolored and transparent or opaque, coloured and transparent or opaque, or having a coloured surface layer.

In the heat-shrinkable resin sheet to be used in this invention, the conditions of the heat shrinkage such as the heat shrinkage rate, the direction in which the sheet has been pre-stretched, the heat shrinkage-initiating temperature, the shrinking tension or force, and the sheet thickness influences the depth and size of the concaves. However, none of them are critical in this invention. Illustratively, when the heat-shrinkage rate of the heat-shrinkable resin sheet is low, the concaves are generally small and shallow, but the depth and size of the concaves can be adjusted by increasing the intensity of the irradiation. When the heat shrinkage-initiating temperature is high the resulting concaves are shallow and small, but in this case also, the depth and size of the concaves can be adjusted by increasing the intensity of the irradiation.

In the instant specification, the term

"sheet" is used to include a film, a thin sheet and a sheet.

The base may comprise any material capable of being laminated to the heat-shrinkable resin sheet. Examples of suitable materials include various types of paper; cellophane (R.T.M.); cellulose ester resins such as cellulose diacetate, cellulose triacetate, and cellulose acetate butylate; polyolefins such as polyethylene and polypropylene, polyvinyl chloride, polyvinylidene chloride polystyrene, polycarbonates, polyvinyl alcohol, polyamides and polyesters, metallic plates and foils, wooden sheets and plywoods, rubber sheets; and laminates made by laminating any combination of them in accordance with known methods. The base materials may be uncoloured and transparent or opaque, or coloured and transparent or opaque.

Formation of a laminated structure from the heat-shrinkable resin sheet and the base can be accomplished by a conventional known method. For instance, an adhesive is coated on one of the heat-shrinkable resin sheet and the base, the other is applied to the adhesive-coated surface and they are bonded together by means of a roll. Known adhesives such as emulsion type adhesives, heat-meltable adhesives, e.g., waxy adhesives, solvent type adhesives, e.g., lacquers, and thermosetting (reactive) adhesives may be used for the above bonding operation.

According to a first embodiment, a laminated structure including a base, a heat-shrinkable resin sheet, and a composite pattern applied to the resin sheet and having heat insensitive areas and heat sensitive areas. Formation of this laminated structure can be accomplished by various procedures. Some embodiments for formation of the laminated structure are described below.

A composite pattern of heat insensitive areas and/or heat sensitive areas is formed on a heat-shrinkable resin sheet or a base prior to formation of a laminated structure from the heat-shrinkable resin sheet and the base, and then the heat-shrinkable resin sheet is bonded to the base so that the heat insensitive areas and the heat sensitive areas do not overlap and together cover the sheet or base. The resultant laminated structure is then subjected to irradiation. According to another embodiment, a heat-shrinkable resin sheet is piled in a base to form a laminated structure, a first pattern of a composite pattern, having heat insensitive areas, is formed on the free surface of the heat-shrinkable resin sheet or on the free surface of the base, and a second pattern of the composite pattern having heat sensitive areas which do not overlap with said heat insensitive areas is formed on the surface of the heat-shrinkable resin sheet, the first and second patterns completely covering the surface of the resin sheet, whereby heat insensitive areas and heat sensitive areas are formed in the laminated structure. As observed above, concaves are formed by local shrinkage of the heat-shrinkable resin sheet caused by the heat energy absorbed selectively through the heat-sensitive areas, and it is therefore desirable that the heat sensitive areas be formed directly on one or both surfaces of the heat-shrinkable resin sheet.

Formation of a laminated structure having heat insensitive areas and heat sensitive areas includes a variety of embodiments. For instance, prior to formation of a laminated structure of a base and a heat-shrinkable resin sheet, heat sensitive areas are formed on the heat-shrinkable resin sheet and/or the base, the base is bonded to the heat-shrinkable resin sheet to form laminated structure, the laminated structure is irradiated with infrared radiation in an amount sufficient for shrinking the heat-shrinkable resin sheet to such an extent that concaves are formed, at least some of which extend through the sheet, and then heat insensitive areas are applied to the resulting laminated structure so that the heat insensitive areas do not overlap the heat sensitive areas but together cover the whole area of the laminated structure.

The positional relationship between heat insensitive and heat sensitive areas, and a laminated structure of a base and a heat-shrinkable resin sheet will now be described. These heat insensitive and heat sensitive areas may be formed on the heat-shrinkable resin sheet, or they may be formed between the base and the heat shrinkable resin sheet. In the latter case, the areas constitute an intermediate layer of the laminated structure. Moreover, it is possible to adopt an embodiment where heat insensitive areas or heat sensitive areas are applied to the heat-shrinkable resin sheet or on one of the surfaces to be bonded together of the base and the heat-shrinkable resin sheet, and the other areas are formed on the heat-shrinkable resin sheet or on the other of the surfaces to be bonded together of the base and the heat-shrinkable resin sheet.

To form a layer of heat sensitive areas and/or a layer of heat insensitive areas on a base or a heat-shrinkable resin sheet, there may be employed an ordinary printing method using an ink such as a photogravure printing method, an offset printing method, a relief printing method, a

screen printing method, an electrostatic printing method or a transfer printing method or a hand-picturing or hand-painting method using a pen or brush. Thus, there can be formed a desired pattern such as of letters, figures, symbols and/or pictures.

Known ink and paint compositions can be used for formation of heat insensitive areas and heat sensitive areas. For instance, it is possible to employ conventional compositions comprising as a main ingredient a vehicle such as a drying oil, a synthetic resin, a processed or modified resin and a natural or synthetic rubber derivative; and incorporated therein additives such as a plasticizer, a stabilizer, a wax-grease, a dryer, an auxiliary dryer, a hardening agent, an emulsifier, a thickening agent, a dispersing agent, and a filler, and such a coloring material as a dye and a pigment, together with a solvent or diluent.

The heat sensitive areas are formed with an ink or paint composition containing a black or dark coloring material having a high infrared radiation absorbability or an ink or paint composition containing a heat absorbent. It is preferred that the ink for forming heat sensitive areas comprise a heat-absorbing coloring agent.

In this invention, the heat insensitive areas and heat sensitive areas can be formed on the front or back surface of the base or the heat-shrinkable resin sheet, or on both the surfaces thereof.

According to the method of this invention, the so formed laminated structure comprising a base, a heat-shrinkable resin sheet, a layer having heat insensitive areas and a layer having heat sensitive areas is irradiated with infrared radiation to cause the heat-shrinkable resin to shrink locally and form concaves, at least some of which comprise holes through the resin sheet. As a source of the infrared radiation, there may be employed, for example, a filament lamp, a discharge lamp, an arc lamp or a flash lamp. Preferably there is employed a heat source capable of radiating near infrared radiation having a peak of spectral distribution in the near infrared region (wavelength being about 1.0 μ), in which the difference of the heat absorption depending on the color in a material to be irradiated is greatest. For instance, a tungsten filament lamp containing a halogen gas, a xenon arc lamp, or a mercury lamp may be employed. Further, the irradiation may be performed by a commercial copying apparatus of the heating type.

When the heat-shrinkable resin sheet or the base is colored, transmission of the radiation is sometimes inhibited to some extent. For this reason, it is preferred that the radiation is irradiated from the surface on which the heat-shrinkable resin sheet is positioned.

The size and depth of the concaves formed in the heat-shrinkable resin sheet by irradiation vary depending on various factors such as the kind of resin, the shrinkage rate of the resin, the thickness of the resin sheet, the hue and concentration and the thickness of the heat sensitive areas, and irradiation speed adopted at the irradiation operation i.e. the speed at which the laminated structure passes under the source of radiation. Accordingly, appropriate conditions depending on the properties of materials constituting the laminated structure are chosen.

Furthermore, the heat-shrinkable resin sheet of the laminated structure may have formed on its face a coating layer for regulating the gloss or luster of the surface of the laminated structure or protecting the surface of the same.

In applying a coating layer onto the laminated structure to be employed in the method of this invention, there may be employed an ordinary coating method such as roll coating, gravure coating, bar coating, flow coating, dip coating, spray coating, using a resin composition obtained by well blending a resin, a filler and a solvent; alternatively a lamination method wherein a film or sheet of resin is laminated to the laminated structure by a conventional method such as an adhesive lamination method or heat-fusion lamination method may be used. Suitable resins for the coating includes for example, natural resins; synthetic resins such as an alkyd resin, a butylated aminoaldehyde resin, a phenolic resin, a vinyl type resin, an acrylic resin, an epoxy resin, a polyurethane resin, a butyral resin; cellulose derivatives such as a nitrocellulose, acetylcellulose or acetyl butyl cellulose or a rubber derivative. The film or sheet of resin may be, for example, polyethylene, polypropylene, a polyester, polyvinylidene chloride, polystyrene, a polycarbonate, polyvinyl alcohol or a polyamide. As the filler, there may be employed titanium oxide, alumina white, gypsum, silica, calcium carbonate, barium sulfate or clay.

As described above, when the laminated structure including a base, a heat-shrinkable resin sheet and a composite pattern having heat sensitive areas and heat insensitive areas is irradiated with a heat radiation, the heat sensitive areas are selectively heated to a higher temperature than other areas. As a result, there is brought about a differential thermal shrinkage of the heat-shrinkable resin sheet. More specifically, the shrinkage is greater at portions corresponding to the

heat sensitive areas than at other portions, with the result that concaves are formed at the portions corresponding to the heat sensitive areas.

The thus obtained decorative laminated structure contains the heat-shrinkable resin sheet having concaves formed locally at portions corresponding to the heat sensitive areas. At other portions, however, the heat-shrinkable resin sheet still retains the heat-shrinkability, and hence, when such a decorative laminated structure is heated at a temperature exceeding the shrinkage-initiating temperature of the heat-shrinkable resin, the resin sheet undergoes further shrinkage, resulting in bending or folding of the decorative laminated structure. In order to improve the thermal properties and obviate the above disadvantages, in accordance with a preferred embodiment of this invention, the laminated structure is subjected to a heat fixation treatment which will now be described.

The decorative laminated structure is heated to a temperature higher than the shrinkage-initiating temperature and the second transition point but lower than the melting point by hot air, hot fluid, far-infrared radiation or hot roller while fixing the peripheral ends of the structure so as to prevent dimensional change. It is desired that the temperature adopted for this operation is higher than the stretching temperature adopted for preparing the heat-shrinkable sheet. The fixation effect is increased by heating the structure to as high a temperature as is possible and allowable. The temperature and time used for this high temperature fixation treatment vary depending on the kind of heat-shrinkable resin sheet or other materials constituting the laminated structure and the thickness thereof, or on the intended use of the resulting decorative laminated structure. Thus, it is preferable to choose suitable temperature and time conditions according to the requirements taking into consideration the foregoing factors.

In order to fix the peripheral ends for preventing the shrinkage of the heat-shrinkable-resin sheet during the above high temperature fixation treatment, there may be employed an apparatus of a design substantially similar to that of an ordinary tentering machine used for woven fabrics. In this case, the laminated structure is heated while feeding the structure in such a state that both longitudinal edges are held by means of a plurality of clips having a width of about 2 to about 5 cm.

By conducting the above-mentioned heat fixation treatment, the remaining heat shrinkability of the heat-shrinkable resin sheet is greatly reduced, and at the same time, the shapes of the concaves formed by the irradiation treatment at portions corresponding to the heat sensitive areas is kept substantially unchanged. However, use of too high a temperature is detrimental to maintenance of the shape of concaves. In practice, for example, when a heat-shrinkable polyester resin sheet having a thickness of 12 μ and a ratio of shrinkability of 40% at 100°C. is heated at 240°C. for 20 seconds by hot air while the edges are fixed, the sheet can be heat-fixed to such an extent that the shrinkability ratio is reduced to 1% at 100°C. Thus, preferred heat-fixing conditions can be simply determined based on simple experiments by those skilled in the art.

As is apparent from the foregoing description when a laminated structure including a base, a heat-shrinkable resin sheet and a composite pattern having heat sensitive areas and heat insensitive areas is irradiated so as to cause the heat-shrinkable resin sheet to shrink locally and form concaves at portions adjacent said heat sensitive areas, and if the laminated structure includes no heat insensitive area such pattern is applied to the heat-shrinkable resin sheet of the resulting laminated structure so that the un-inked heat insensitive areas are between the required concaves formed in said heat-shrinkable resin sheet, there can be obtained a decorative laminated structure having on the surface a pattern of concaves in which the heat sensitive areas present at portions corresponding to said concaves fill in the gaps between the heat insensitive areas, which pattern is excellent in strength, durability and full of beauty, reality and which exhibits an excellent illusion of surface relief.

Moreover, it will readily be understood that, since the heat sensitive areas can be easily formed by printing to render the pattern of the heat sensitive areas fine and delicate, it is possible to form a correspondingly intricate pattern of concaves on the heat-shrinkable resin sheet at portions corresponding to the heat sensitive areas, thus affording to the resulting laminated structure a realistic effect, which is further enhanced by the heat insensitive areas formed so that they cover the areas between the concaves, i.e., the heat sensitive areas. Further, also the heat insensitive areas can be easily formed by printing. Thus, such a delicate and fine pattern including concaves not attainable by the conventional methods can be easily obtained.

Further, since concaves in this invention are formed not by such mechanical means as embossing rolls or mold plates but by utilizing the difference in temperature

caused by the difference in heat absorption in the heat-shrinkable resin sheet, the size and depth of concaves can be easily adjusted by changing the heat absorption at the heat sensitive areas, with the result that more realistic decorative laminated structures is obtained.

Still further, when heat sensitive areas are formed directly on the surface of the heat-shrinkable resin sheet, concaves formed in the heat-shrinkable resin sheet can be colored with the same colour as that of the heat sensitive areas.

In addition, formation of such a decorative laminated structure can be accomplished without employing a metallic mold roll or metallic mold plate as used in the conventional methods, only by inserting a heat irradiation in the printing step. As a result, the desired decorative laminated structures can readily be mass-produced at low costs.

Moreover, when the resulting laminated structure is subjected to the heat fixation treatment according to preferred embodiments of this invention, the fastness and resistance of the decorative laminated structure, especially heat resistance and thermal characteristics, can be highly improved.

Decorative laminated structures of this invention have, alone or in combination with other structures, a wide variety of uses, for example, not only as materials for ceilings, floors, walls and interior decorations of buildings, cars and ships, but also as decorative materials for furniture, such as tables and cabinets, fittings, and musical instruments.

The invention will be further described by way of example only with reference to the accompanying drawings in which Figs. 1 to 13 are enlarged views illustrating modes of forming decorative laminated structures of this invention, which are specifically disclosed in Examples given hereinafter.

This invention is now illustrated in connection with the accompanying drawings, but not limited, by the following examples, in which the shrinkability ratio of the heat-shrinkable sheet was determined according to the method of ASTM D1204 at 100°C. and for 5 minutes. Each of the figures is a cross-sectional view showing various types of decorative laminated structure and a method for making thereof according to the present invention.

Example 1

As is illustrated in Fig. 1-a, a grain pattern portion 2 of a wood grain pattern was gravure-printed on a heat shrinkable polyvinyl chloride resin film 1 (manufactured and sold by Mitsubishi Plastics, Ind., Ltd., Japan Trade name: Hishirex-502. Shrinkage rate: laterally 45—50%. Thickness: 40 μ) using a dark ink composition comprising as a vehicle a vinyl chloride-vinyl acetate copolymer.

Also as illustrated in Fig. 1-a. a wood pattern 3 co-ordinating with the grain pattern portion 2 was gravure-printed on the above heat-shrinkable polyvinyl chloride resin film 1 using a brown ink composition comprising as a vehicle a vinyl chloride-vinyl acetate copolymer.

Then, as illustrated in Fig. 1-b, a brown-colored heat-resistant polyvinyl chloride sheet 4 (manufactured and sold by Riken Vinyl Ind. Co., Ltd., Japan. Trade name: Riken Film FC-4648. Thickness: 100 μ) was bonded to the back surface of the heat-shrinkable polyvinyl chloride resin film 1 using an adhesive of the vinyl chloride-vinyl acetate copolymer type to obtain a laminated structure A.

The resulting laminated structure A was irradiated with infrared radiation 5 at an irradiation speed of 6.9 cm/sec. over the printed surface of the structure A using a heating type copying machine (manufactured and sold by Duplo Manufacturing Co. Trade name: Duplo Fax-631), as is illustrated in Fig. 1-c. As a result, the part of the heat-shrinkable film 1 below the grain pattern portions 2 shrank and concaves 6, at least some of which shrank to such an extent that the heat resistant sheet 4 was directly colored with a color of the portions 2, were formed. Thus was obtained a decorative laminated structure having a three-dimensional pattern.

The above procedures were repeated employing a lined paper having the surface brown-colored (manufactured and sold by Kohjin Co., Ltd., Japan. Trade name: WK-130. Thickness: 230 μ) instead of the heat-resistance polyvinyl chloride resin sheet 4 and using an adhesive having ethylene-vinyl acetate copolymer as a vehicle to obtain a wall paper having a three-dimensionally decorated face.

The above procedures were repeated except that a wood pattern 3 was first applied and a grain pattern portion 2 was then applied. A similar decorative laminated structure exhibiting a similar decorative effect was obtained.

Further, the above procedure was repeated by employing instead of the above heat-shrinkable polyvinyl chloride resin film, a heat-shrinkable polyvinylidene chloride resin film, a polyester film, a polyamide film, a polystyrene film, a polyethylene film or a polypropylene film. In each case, a decorative laminated structure having a three-dimensional effect

similar to that of the product obtained above, was obtained.

Example 2

Colored figure portions 2 of an arabesque design were gravure-printed, as illustrated in Fig. 2, on a rigid polyvinyl chloride resin film 4 (manufactured and sold by Kobe Resin Co., Ltd., Japan. Trade name: Bonloid. Thickness: 100 μ) using a black ink composition comprising as vehicle a polyvinyl chloride resin. The remainder 3 of the design was gravure-printed using a green ink composition comprising as vehicle a polyvinyl chloride resin.

A heat-shrinkable polyvinyl chloride resin film 1 (manufactured and sold by Mitsubishi Plastics Ind., Ltd., Japan. Trade name: Hishirex. Thickness: 40μ. Shrinkage rate: laterally 45—50%) was bonded to the printed surface of the above rigid polyvinyl chloride film 4 by an adhesive having vinyl chloride-vinyl acetate copolymer as a vehicle to obtain a laminate structure B.

As is illustrated in Fig. 2, the structure B was irradiated with infrared radiation 5 at an irradiation speed of 4.7 cm/sec. by means of the same heating type copying machine as used in Example 1. As a result, colored figure portions 2 and concaves 6, above at least some of which shrank to such an extent that the coloured figure portions were uncovered i.e. holes were formed in the heat-shrinkable film 1, were formed. Thus was obtained a decorative laminated structure having a three-dimensional effect.

A similar decorative laminated structure having a three-dimensional effect was obtained by conducting the above procedures in the same manner except that colored figure portions 2 and the remainder of the design 3 were formed not on the rigid polyvinyl chloride resin film 4 but on the back surface of the heat-shrinkable polyvinyl chloride resin film 1 and the film 4 was bonded to the printed surface of the film 1 to obtain a composite laminated structure B, which was treated in the same manner as above.

Example 3

As is shown in Fig. 3, grain pattern portions 2 of a wood pattern were printed on a heat-shrinkable polypropylene film 1 (manufactured and sold by Kohjin Co., Ltd., Japan. Trade name: Polyset. Thickness: 30 μ) using a black ink composition comprising as vehicle a polyamide resin.

A wood pattern 3 was gravure-printed on the back surface of the above heat-shrinkable film 1 using brown ink composition comprising as vehicle a polyamide resin.

Then, as is illustrated in Fig. 3, a light brown-colored, thick paper 4 (manufactured and sold by Kohjin Co., Ltd., Japan. Trade name: WK-130. Base weight: 130 g/m^2) was bonded to the surface of the heat-shrinkable film 1, on which the wood pattern 3 had been printed, by an adhesive using ethylene-vinyl acetate copolymer as vehicle to obtain a laminated structure C.

As is illustrated in Fig. 3, the laminated structure C was irradiated over the heat-shrinkable film 1 with infrared radiation 5 at an irradiation speed of 4.7 cm/sec. using the same heating type copying machine as used in Example 1. As a result, the part of the heat-shrinkable film below the grain pattern portions 2 shrank and concaves 6, at least some of which shrank to such an extent that the heat-resistance sheet 4 was directly colored with a color of the grain pattern portions 2 were formed. Thus was obtained a decorative laminated structure having a three dimensional effect.

The above procedure was repeated except that the wood pattern 3 was printed on the front surface of the heat-shrinkable polypropylene film 1 and the grain pattern portion 2 were printed on the back surface of the film 1. Thus was obtained a decorative laminated structure similar to the above product except that the wood pattern was presented on the surface.

Example 4

A solid brown-colored layer 7 was formed by gravure-printing on the surface of a stencil paper 4 (manufactured and sold by Tokushu Paper Making Co., Japan. Trade name: S-Velum. Base weight: 80 g/m^2), as illustrated in Fig. 4.

A wood pattern 3 was gravure-printed on the layer 7 using a brown ink composition comprising as vehicle a polyvinyl chloride resin.

Then, a heat-shrinkable polyester film 1 (product of Mitsubishi Plastics Ind., Ltd., Japan. Thickness: 12μ) was applied on the surface of the stencil paper 4, on which the wood pattern 3 had been printed, by a polyester resin adhesive to obtain a laminated structure.

Grain pattern portions 2 which are heat-sensitive were printed on the heat-shrinkable film 1 of the above laminated structure using a black ink composition comprising as vehicle a polyester resin to obtain a composite laminated structure D.

The structure D was irradiated with an infrared ray 5 at an irradiation speed of 3.2 cm/sec. over the heat-shrinkable film 1 of the composite layer structure D by employing the same heating type copying machine as used in Example 1, in a manner as illustrated in Fig. 4. As a result, the portions of the heat-shrinkable film 1 below the grain pattern portions 2 shrank and

concaves 6, at least some of which shrank to such an extent that the layer 7 was directly colored with a color of the portions 2, were formed. Thus a decorative laminated structure having a three-dimensional effect was obtained.

When the laminate structure D was prepared by printing the grain pattern portions 2 on the heat-shrinkable resin film 1 prior to bonding the film 1 to the stencil paper 4, a decorative laminated structure exhibiting similar three-dimensional effect was obtained.

Example 5

As is illustrated in Fig. 5, a solid brown-colored layer 7 was formed by gravure-printing on a lined paper 4 (manufactured and sold by Kohjin Co., Ltd., Japan. Trade name: WK-80. Base weight: 80 g/m²) using a brown ink composition comprising as vehicle a vinyl chloride-vinyl acetate copolymer resin.

Then, a heat-shrinkable polyvinyl chloride resin film 1 (manufactured and sold by Nippon Carbide Ind., Co., Ltd., Japan. Trade name: Hi-S Film #111L Shrinkage rate: laterally 50% and longitudinally 5%. Thickness: 40μ) was bonded on the side of the solid colored layer 7 of the lined paper 4 by an adhesive with ethylene-vinyl acetate copolymer as vehicle.

Grain pattern portions 2 and a wood pattern 3 were applied to the surface of the heat-shrinkable film of the above bonded assembly in the same manner as in Example 1 to obtain a laminated structure E.

Then, as illustrated in Fig. 5, the composite layer structure E was irradiated with infrared radiation 5 at an irradiation speed of 7.5 cm/sec. from the printed surface side of the laminated structure E by employing the same heating type copying machine as used in Example 1. As a result, shrinking of the heat-shrinkable film and formation of concaves 6 were caused to occur in the same manner as in Example 1, and a decorative laminated structure exhibiting a three-dimensional effect similar to that of the product of Example 1 was obtained.

Similar decorative laminated structures were obtained by employing, instead of the above heat-shrinkable polyvinyl chloride resin film, a heat-shrinkable polyvinylidene chloride film, a polyester film, a polyamide film, a polystyrene film, a polyethylene film and polypropylene film.

Also similar decorative laminated structures were obtained by employing, instead of the above lined paper 4 with the surface coated with the solid colored layer 7, a brown-colored aluminum foil, an asbestos paper and a colored polyvinyl chloride film.

Example 6

As is shown in Fig. 6, an acrylic resin (manufactured and sold by Rohm and Haas. Trade name: Palaloid B-66.) containing, dispersed therein, 5% by weight of silica as a delustrant (manufactured and sold by Fuji Davison Chemical Co., Ltd., Japan. Trade name: Syloid 308) was coated on the entire printed surface of the laminated structure E obtained in Example 5 to form a laminated structure F having a delustered transparent layer 8 having a thickness of about 3 μ.

Then, as is illustrated in Fig. 6, the laminated structure F was irradiated with infrared radiation 5 at an irradiation speed of 8.3 cm/sec. from the side of the transparent layer 8 by using the same heating type copying machine as employed in Example 1. As a result, the portions of the heat-shrinkable film 9 below the grain pattern portions 2 shrank forming concaves 6', at least some of which shrank to such an extent that the layer 7 was directly colored with a color of the grain pattern portions 2 which was covered by the transparent layer 8. Thus was obtained a decorative laminated structure having a pattern excellent in the three-dimensional effect.

Example 7

As is illustrated in Fig. 7-a, grain pattern portions 2 of a wood grain pattern were gravure-printed on a heat-shrinkable polyvinyl chloride resin film 1 (manufactured and sold by Mitsubishi Plastics Ind., Ltd., Japan. Trade name: Hishirex-502. Thickness: 40μ. Shrinkage rate: laterally 45—50%) using a black ink composition comprising as vehicle a vinyl chloride-vinyl acetate copolymer.

Also as is illustrated in Fig. 7-a, a heat-resistant polyvinyl chloride sheet 4, which had been coated with a vinyl chloride-vinyl acetate copolymer adhesive and then colored brown, was bonded to the back surface of the heat-shrinkable polyvinyl chloride resin film 1 with the front surface being printed with grain pattern portions 2, to thereby form a laminated structure G.

Then, as is illustrated in Fig. 7-a, the composite layer structure G was irradiated with infrared radiation 5 at an irradiation speed of 6.5 cm/sec from the side of the printed surface of the laminated structure G by employing a heating type copying machine (manufactured and sold by Duplo Manufacturing Co. Japan. Trade name: Duplo Fax-63). As a result, the part of the heat-shrinkable film below the grain pattern portions 2 shrank forming concaves 6, at least some of which shrank to such an

extent that the heat-resistance sheet 4 was directly colored with a color of the grain pattern portions 2.

Then, as is illustrated in Fig. 7-b, a wood pattern 3 was gravure-printed on the laminated structure using a brown ink composition comprising as a vehicle a vinyl chloride-vinyl acetate copolymer. Thus was obtained a decorative laminated structure providing the illusion of relief.

A decorative wall paper having a three-dimensionally decorated face similar to that of the above decorative structure was similarly obtained by employing, instead of the above heat-resistance polyvinyl chloride sheet 4, a lined paper (manufactured and sold by Kohjin Co., Ltd., Japan. Trade name: WK-130. Thickness: 230 μ) having the surface colored brown, and an adhesive, having ethylene-vinyl acetate copolymer as vehicle, for the bonding.

Similar decorative laminated structures were prepared by conducting the above procedures by employing, instead of the heat-shrinkable polyvinyl chloride resin film, a heat-shrinkable polyvinylidene chloride film, a polyester film, a polyamide film, a polystyrene film, a polyethylene film and a polypropylene film.

Example 8

As is illustrated in Fig. 8-a, a solid brown-colored layer 7 was gravure-printed on the surface of a stencil paper 4 (manufactured and sold by Tokushu Paper Making Co., Japan Trade name: S-Velum. Base weight: 80 g/m^2).

Also as illustrated in Fig. 8-a, the above stencil paper 4 was bonded to a heat-shrinkable polyester film 1 (manufactured by Mitsubishi Plastics Ind., Ltd., Japan. Thickness: 12μ) to form a laminated structure H. Then, grain pattern portions 2 of a pattern of grains of wood were gravure-printed on the film 1, and the shrinking and forming of concaves 6 performed by employing the same heating type copying machine as used in Example 1.

Then, as is illustrated in Fig. 8-b, on the heat-shrinkable polyester film 1 having concaves 6, a wood pattern 3 was gravure-printed to obtain a decorative laminated structure having a pattern excellent in the three-dimensional effect.

Similar decorative laminated structures were obtained by repeating the above procedures by employing, instead of the above heat-shrinkable polyester resin film, a polyvinylidene resin film, a polyvinyl chloride resin film, a polyamide resin film, a polystyrene resin film, a polyethylene resin film and a polypropylene resin film. Also similar decorative laminated structures were obtained by repeating the above procedures by employing, instead of the lined paper 4, a brown-colored aluminum foil, an asbestos paper and a colored polyvinyl chloride film.

Example 9

As is illustrated in Fig. 9-a, grain pattern portions 2 were gravure-printed on a thick paper A (manufactured and sold by Kohjin Co., Ltd., Japan. Trade name: WK-130. Base Weight: 130 g/m^2) having the surface colored a light brown color, using a black ink composition comprising as a vehicle a polyamide resin.

Then, as is shown in Fig. 9-a, a heat-shrinkable polypropylene film 1 (manufatured and sold by Kohjin Co., Ltd., Japan. Trade Name: Polyset. Thickness of 30 μ) was bonded to the above thick paper 4 using an adhesive having ethylene-vinyl acetate copolymer as vehicle to form a laminated structure I. Then, the composite layer structure was irradiated with infrared radiation 5 at an irradiation speed of 4.7 cm/sec. employing the same heating type copying machine as used in Example 1. As a result, the portion of the heat-shrinkable film below the grain pattern portions 2 shrank to form concaves at least some of which shrank to such an extent that the heat-resistant sheet 4 was directly colored with a color of the portions 2.

Then, as is illustrated in Fig. 9-b, a wood pattern 3 was gravure-printed on the surface of the heat-shrinkable film of the above laminated structure using a brown ink composition comprising the same vehicle as of the ink used for formation of the grain pattern portions 2, to thereby obtain a decorative laminated structure.

Example 10

As is illustrated in Fig. 10-a, dark-colored grain pattern portion 2 and lighter colored grain pattern portion 2′ were gravure-printed on a heat-shrinkable polyvinyl chloride resin film 1 (manufactured and sold by Mitsubishi Plastics Ind. Ltd., Japan. Trade name: Hishirex 502-Z. Shrinkage rate: laterally of 45—50%. Thickness: 40μ) using a dark black ink composition comprising as vehicle a vinyl chloride-vinyl acetate copolymer. Similarly, further grain pattern portions 2″ were printed in the same manner as the above except that a dark brown ink composition is used.

Then, also as illustrated in Fig. 10-a, a wood pattern 3 was gravure-printed on the heat-shrinkable polyvinyl chloride resin film 1 using a light brown ink composition comprising as vehicle a vinyl chloride-vinyl acetate copolymer.

Then, as is illustrated in Fig. 10-b, on the back surface of the heat-shrinkable resin film 1 with the front surface printed with

the wood pattern 3 and the grain pattern portions 2, 2' and 2", a cream colored heat-resistant polyvinyl chloride sheet 4 (manufactured and sold by Riken Vinyl Ind. Co., Ltd., Japan. Trade name: FC-4648 Thickness: 100μ) was bonded by vinyl chloride-vinyl acetate copolymer adhesive, to form a laminated structure J.

Then, as is illustrated in Fig. 10-c, the laminated structure J was irradiated from the printed surface side thereof with infrared radiation 5 at an irradiation speed of 7.5 cm/sec. to supply energy sufficient to cause the heat-shrinkable film 1 below the dark-colored grain pattern portions 2 only to shrink to such an extent that the heat-resistant film 4 was directly colored by employing a heating type copying machine (manufactured and sold by Duplo Manufacturing Co., Japan. Trade name: Duplo Fax-631), the grain pattern portions 2 only thus forming concaves 6. The lighter-colored grain pattern portions 2' and 2" were caused to shrink and form concaves 6' and 6" colored with a color of the grain pattern portions 2' and 2", respectively. Thus was obtained a decorative laminated structure of a pattern having a three-dimensional effect.

Then, as is illustrated in Fig. 10-d, the composite layer structure J was subjected for 20 seconds to a heat fixation treatment in a hot air furnace 11 maintained at 140°C. both edges of the structure J being fixed with clips 12 so as to reduce the remaining heat shrinkage rate of the heat-shrinkable polyvinyl chloride resin film 1 to 15%.

A laminated structure was prepared by repeating the above procedure employing, instead of the heat-resistant polyvinyl chloride sheet base 4, a lined paper (manufactured and sold by Kohjin Co., Ltd., Japan. Trade name: WK-130. Thickness: 230μ) whose surface had been colored cream, and an adhesive having ethylene-vinyl acetate copolymer as vehicle, and the laminated structure was irradiated with infrared radiation and subjected to a heat fixation treatment in the same manner as above, to obtain a three-dimensional wall paper excellent in heat resistance.

The above procedure was repeated in the same manner except that a transparent polyvinyl chloride film (manufactured and sold by Kobe Resin Co. Ltd., Japan. Trade name: Bonloid. Thickness: 100 μ) was bonded to the base 4 and infrared irradiation was effected from the direction reverse to the above, i.e., from the polyvinyl chloride film side of the base 4, at an irradiation speed of 6.0 cm/sec., followed by the heat fixation treatment, whereby a decorative laminated structure having a pattern of a three-dimensional effect similar to that of the above decorative laminated structure was obtained.

Similar decorative laminated structures having a pattern of a three-dimensional effect were prepared by repeating the above procedures by employing, instead of the heat-shrinkable polyvinyl chloride resin film, a heat-shrinkable polyvinylidene type film, a polyester type film, a polyamide type film, a polystyrene type film, a polyethylene type film and a polypropylene type film.

When, in the above-mentioned procedures for forming the decorative laminated structure and wall paper, the heat-shrinkable film 1 was at first bonded to the base 4 and grain pattern portions 2, 2' and 2" and wood pattern 3 were printed on the surface of the heat-shrinkable film 1, products exhibiting similar decorative effects were obtained.

Example 11

As is illustrated in Fig. 11-a, grain pattern portions 2 of a wood grain pattern were gravure-printed on a heat-shrinkable polyester film 1 (manufactured and sold by Mitsubishi Plastics Ind. Ltd., Japan. Trade name Diafoil HS. Average heat shrinkage rate: 40%. Thickness: 12 μ) using a dark black ink composition comprising as vehicle a polyester resin.

Then, a wood pattern 3 was further gravure-printed on the heat-shrinkable resin film 1 using a brown ink composition comprising the same vehicle as the above dark black ink composition.

Then, a stencil paper 4 (manufactured and sold by Tokushu Paper Making Co., Japan. Trade name: S-Velum. Base weight: 80 g/m^2), the surface of which had been colored brown, was bonded to the heat-shrinkable polyester film 1 on the side on which the wood pattern 3 and grain pattern portions 2 had been printed, to thereby form a laminated structure K.

Then, as illustrated in Fig. 11-b, the laminated structure L placed on a roll 10 was irradiated at an irradiation speed of 3.0 cm/sec. by employing a near infrared ray lamp 9 (manufactured by Ushio Electric Inc., Japan; 200 V and 1.2 KW) from the side of the heat shrinkable resin film 1 of the laminated structure K. As a result, the portion of the film 1 over the grain pattern portions 2 shrank to such an extent that the portions 2 were uncovered and concaves 6 were formed. Then, in the same manner as in Example 10, the laminated structure L was subjected to a heat fixation treatment for 30 seconds in a hot air furnace maintained at 240°C, while keeping the size of the structure L constant. As a result, the remaining heat shrinkage rate of the heat-shrinkable polyester film 1 was reduced to

1%, and a decorative laminated structure having a three-dimensional pattern was obtained.

The above procedure was repeated by employing as the base 4 a polyester film (manufactured and sold by Mitsubishi Plastics Ind. Ltd., Japan. Trade name: Lumirror. Thickness: 50 μ) and irradiating the resulting laminated structure at an irradiation speed of 2.2 cm/sec. in the direction reverse to the above, i.e., from the side of the polyester film base 4, followed by the heat fixation treatment. As a result, a decorative laminated structure exhibiting similar decorative effects was obtained.

Example 12

Colored figure portions 2 of an arabesque design were gravure-printed on a rigid polyvinyl chloride resin film 4 (manufactured and sold by Kobe Resin Co. Ltd., Japan. Trade name: Bonloid. Thickness: 100 μ) using a black ink composition comprising as vehicle a polyvinyl chloride resin, as illustrated in Fig. 12, and the remainder 3 of the design was gravure-printed using a green ink composition comprising the same vehicle as that of the above black ink. Then, a heat-shrinkable polyvinyl chloride resin film 1 (manufactured and sold by Mitsubishi Plastics Ind. Ltd., Japan. Trade name: Hishirex. Shrinkage rate: laterally 40—50%. Thickness: 40 μ) was bonded to the printed surface of the rigid polyvinyl chloride resin film 4 to obtain a laminated structure L. Then, also as illustrated in Fig. 12, the laminated structure L was irradiated with infrared radiation 5 at an irradiation speed of 4.7 cm/sec. employing the same heating type copying machine as used in Example 10. As a result, the colored figure portions 2 shrank to form concaves 6", the heat-shrinkable film 1 above at least some of the portions 2 shrinking to such an extent that the portions 2 were uncovered. The resulting composite laminated structure L was subjected to the heat fixation treatment in the same manner as in Example 10 to obtain a decorative laminated structure having a three-dimensional pattern and excellent in heat resistance, in which the concaves 6" were colored with a color of the colored figure portions 2.

Example 13

As is illustrated in Fig. 13-a, a solid, brown-colored layer 7 was gravure-printed on the entire surface of a stencil paper 4 (manufactured and sold by Tokushu Paper Making Co., Japan. Trade name: S-Velum. Base weight: 80 g/m²).

Then, also as illustrated in Fig. 13-a, the above stencil paper 4 was bonded to a heat-shrinkable polyester film 1 (manufactured by Mitsubishi Plastics Ind. Ltd., Japan. Thickness: 12 μ) to obtain a laminated structure M. Grain pattern portions 2 were gravure-printed on the film 1 and concaves 6" were formed at portions above the grain pattern portions 2 by employing the same heating type copying machine as used in Example 10.

Then, as is illustrated in Fig. 13-b, a wood pattern 3 was gravure-printed on the heat-shrinkable polyester film with the concaves 6" thereon, and the laminated structure was subjected to a heat fixation treament in the same manner as in Example 10 to obtain a decorative laminated structure having a pattern full of the three-dimensional effect.

Similar decorative laminated structures were obtained by repeating the above procedures by employing, instead of the above heat-shrinkable polyester film 1, a heat-shrinkable polyvinyl chloride resin film, a heat-shrinkable polyvinylidene chloride film, a polamide resin film, a polystyrene resin film, a polyethylene resin film and a polypropylene resin film. Also similar decorative laminated structures were prepared by repeating the above procedures by employing, instead of the above stencil paper 4, a brown-colored aluminum foil, an asbestos paper and a colored polyvinyl chloride film.

WHAT WE CLAIM IS:—

1. A decorative laminated structure comprising a base, a sheet made from a heat-shrinkable resin, and a composite pattern consisting of one or more layers applied thereto, the composite pattern comprising a first pattern of a heat-sensitive ink composition contacting the resin sheet, and containing a heat-absorbing colouring agent and a second pattern comprising the parts of the composite pattern not covered by the heat-sensitive ink composition of the first pattern, of a heat insensitive ink composition, the portions of the heat-shrinkable resin sheet covered by the first pattern having been shrunk to form concaves, at least some of which form holes through the heat-shrinkable resin sheet.

2. A decorative laminated structure as claimed in claim 1, wherein any heat-shrinkability of the heat-shrinkable resin sheet remaining after formation of the concaves has been fixed by a heat treatment conducted at elevated temperatures while keeping the dimension of the structure constant.

3. A decorative laminated structure as claimed in claim 1, wherein the heat-shrinkable resin sheet having concaves has on its outer surface an overcoat layer for protecting and/or delustering said surface.

4. A decorative laminated structure as claimed in claim 1, wherein the heat-

shrinkable resin sheet is a thermoplastic resin sheet stretched in a predetermined direction.

5. A decorative laminated structure as claimed in claim 4, wherein the thermoplastic resin sheet comprises polyvinyl chloride, polyvinylidene chloride, a polyolefin, polystyrene, a polyester, a polycarbonate, or polyvinyl alcohol.

6. A decorative laminated structure as claimed in claim 1, wherein the base is adhered to the heat-shrinkable resin sheet by an adhesive.

7. A decorative laminated structure as claimed in claim 1, wherein the portions of the base exposed by the concaves remain covered by the first pattern after formation of the concaves.

8. A method of making a decorative laminated structure, in which a laminated structure, comprising a base and a sheet of heat-shrinkable resin on which is applied a first pattern consisting of heat absorbing areas, is irradiated with infra-red or near infra-red radiation, heat energy being absorbed by the areas of the first pattern to heat up and cause to shrink and form concave portions of heat-shrinkable resin sheet covered thereby, the amount of radiation and variations in heat absorbing properties of the first pattern resulting in at least some of the portions shrinking to such an extent that holes are formed in the heat-shrinkable resin sheet, a second pattern of a heat-insensitive ink composition being applied either before or after irradiation on the heat-shrinkable resin sheet and consisting of at least one layer, the second pattern including at least those areas of the heat-shrinkable resin sheet not covered by the first pattern.

9. A method as claimed in claim 8, wherein an overcoat layer is coated on the structure before or after the irradiation treatment.

10. A method as claimed in claim 8, wherein the heat-shrinkable resin sheet is a thermoplastic resin sheet stretched in a predetermined direction.

11. A method as claimed in claim 10, wherein the thermoplastic resin comprises polyvinyl chloride, polyvinylidene chloride, a polyolefin, polystyrene, a polyester, a polyamide, a polycarbonate, polyvinyl alcohol, or a cellulose ester resin such as cellulose diacetate, cellulose triacetate or cellulose acetate butylate.

12. A method as claimed in claim 8, wherein the base is composed of a material capable of being bonded to the heat-shrinkable resin sheet.

13. A method as claimed in claim 8, wherein the heat absorbing areas are formed of a heat sensitive ink composition containing a heat-absorbing material.

14. A method as claimed in claim 13, wherein the heat-absorbing material is a heat-absorbing coloring agent.

15. A method as claimed in claim 8, wherein the resulting laminated structure is further heat-treated at an elevated temperature while fixing the peripheral edges of the structure to effect heat fixation of the heat-shrinkable resin to reduce the heat shrinkability thereof.

16. A method as claimed in claim 15, wherein the heat fixation treatment is carried out at a temperature higher than the shrinkage-initiating temperature and the second transition point of the heat-shrinkable resin sheet but lower than the melting point thereof.

17. A method as claimed in claim 15, wherein the heat fixation treatment is carried out at a temperature higher than the temperature at which the heat-shrinkable resin sheet has been stretched at the time of preparation thereof.

18. A decorative laminated structure made by a method as claimed in any of claims 8 to 17.

19. A decorative laminated structure substantially as hereinbefore described with reference to any of the examples given.

20. A method of making a decorative laminated structure substantially as hereinbefore described with reference to any of the examples given.

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FIG. 1a

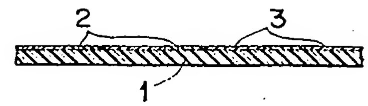


FIG. 1b

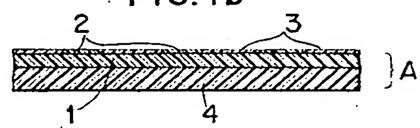


FIG. 1c

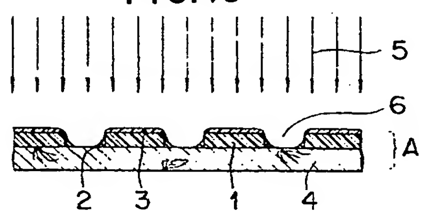


FIG. 2

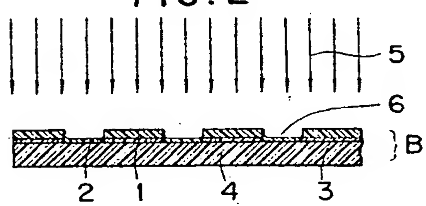


FIG. 3

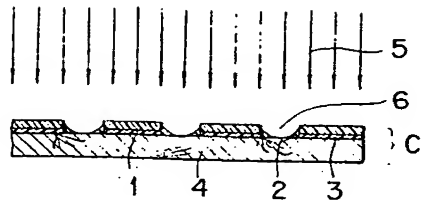


FIG. 4

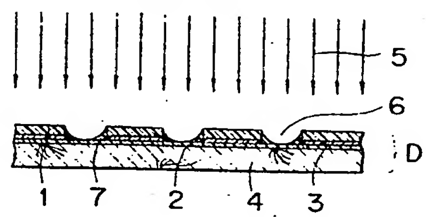
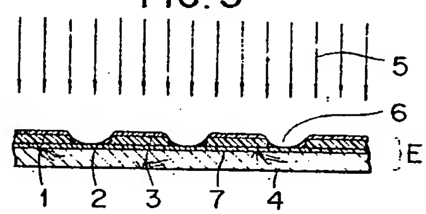


FIG. 5



1433192 COMPLETE SPECIFICATION

7 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 3

FIG. 6

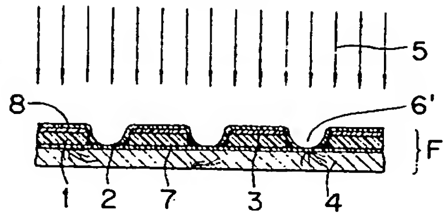


FIG. 7a

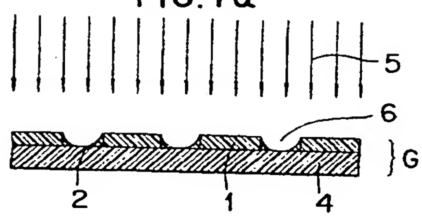


FIG. 7b

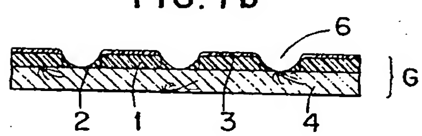


FIG. 8a

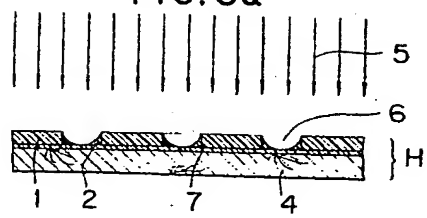


FIG. 8b

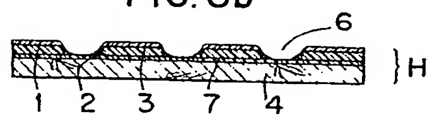


FIG. 9a

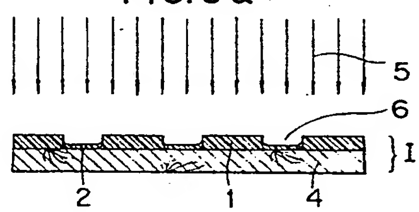


FIG. 9b

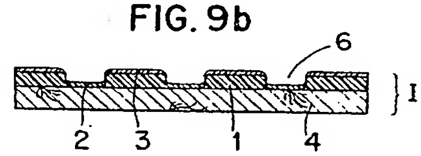


FIG. 10a

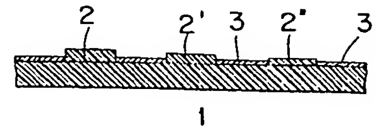


FIG. 10b

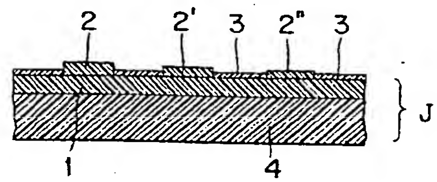


FIG. 10c

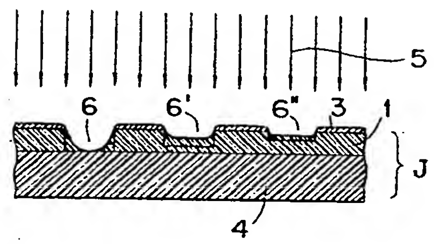


FIG. 10d

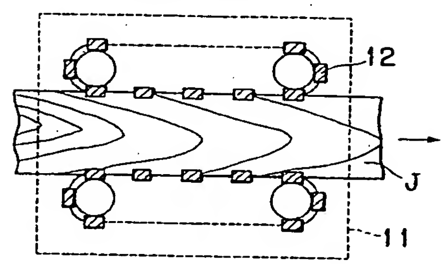


FIG. 11a

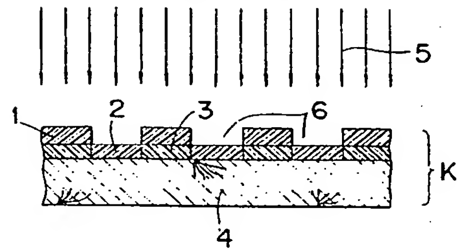


FIG. 11b

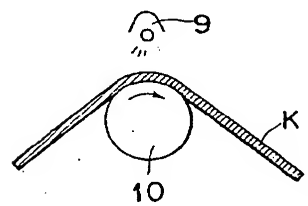


FIG. 12

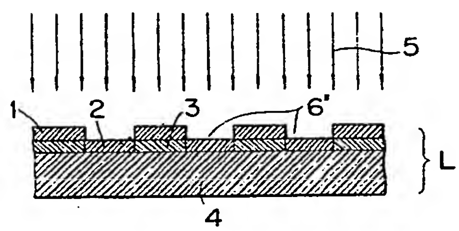


FIG.13a

FIG.13b